ARMY RESEARCH LABORATORY

The ARL Army Experiment 3 Individual Combatant/Military Operations on Urbanized Terrain (MOUT) Demonstration

by Mark A. Thomas

ARL-TN-102

January 1998

The findings in this report are not to be construed as an official Department of the Army position unless so designated by other authorized documents.

Citation of manufacturer's or trade names does not constitute an official endorsement or approval of the use thereof.

Destroy this report when it is no longer needed. Do not return it to the originator.

Army Research Laboratory
Aberdeen Proving Ground, MD 21005-5067

ARL-TN-102 **January 1998**

The ARL Army Experiment 3 Individual Combatant/Military Operations on Urbanized Terrain (MOUT) Demonstration

Mark A. Thomas
Information Science and Technology Directorate, ARL

Abstract

In October 1996, the U.S. Army presented a demonstration of wargaming and virtual prototyping at the Annual Association of the U.S. Army (AUSA) Convention in Washington, DC. The demonstration showcased interactive simulation and its use in military operation planning, situational awareness, battlefield coordination, and infantry tactics. The U.S. Army Research Laboratory (ARL) participated by demonstrating infantry tactics in an urban area. The ARL demonstration included dismounted infantry (DI) maneuvering in a built-up area to clear a building, and dynamic effects on terrain and manmade structures. This report describes the ARL military operations on urbanized terrain (MOUT) demonstration.

Acknowledgments

The author would like to thank the following individuals for their support of this demonstration: Ms. Virginia To for administrative and test support, Mr. Kelly Kirk and Mr. Andrew Neiderer for programming and test support, Mr. Jim Faughn for assistance in modifying the McKenna MOUT database, and Mr. Pete Fazio for ModSAF scenario support.

INTENTIONALLY LEFT BLANK.

Table of Contents

INTENTIONALLY LEFT BLANK.

List of Figures

INTENTIONALLY LEFT BLANK.

1. Introduction

In October 1996, the U.S. Army presented a demonstration of future military technologies and virtual simulation. Named the Army Experiment 3 (AE3), live, constructive, and virtual simulations were integrated to demonstrate the use of simulation in military acquisition, planning, and coordination. The technologies involved in the AE3 included wide area networking, distributed interactive simulation (DIS), dismounted infantry (DI), military operations on urbanized terrain (MOUT), and virtual prototyping. The demonstration brought together Army assets from industry, Army schools and centers, and research laboratories.

The U.S. Army Research Laboratory (ARL) participated in the exercise with its DIS, dynamic terrain, and weapons effects on buildings. The DI scenario presented virtual soldiers maneuvering and fighting in a simulated urban environment. The simulation showcased ARL simulation techniques in DIS, real-time weapons effects modeling, and dynamic terrain research. This report will describe the ARL DI scenario and the exercise setup to perform the simulation.

2. Scenario

The ARL DI demonstration showed the tactical scenario of DI covering a demolition expert who maneuvers to a building and emplaces an explosive charge. While the DI maneuvered to the building to clear it through the hole blown into it by the explosive charge, a Bradley fighting vehicle maneuvered through a crater formed from enemy artillery fire.

The ARL DI scenario was a 30-s vignette. The scenario involved four dismounted soldiers clearing a building in an urban area. The urban area was a model of the McKenna MOUT site at Fort Benning, GA (Figure 1). One soldier emplaced an explosive on the side of a building, while the others provided covering fire. When the explosive fired, it blew a hole into the side of the building. The soldiers then maneuvered to the hole, and two soldiers entered to clear the building while the

Figure 1. McKenna MOUT Site.

others provided covering fire and overwatch. Simultaneously, a Bradley fighting vehicle moved up the road next to the building and maneuvered through a crater formed from enemy artilley fire. The scenario required exact timing of events to conform to the requirements of the AE3 scenario.

The simulation was displayed on three 12-ft × 12-ft screens. Two screens displayed the DI action, and the third screen showed a view of the Bradley maneuverin through the dynamically formed crater.

3. Exercise Setup

The ARL demonstration used the ARL STEALTH, ModSAF, and the ARL DIS manager software. The ARL STEALTH (STEALTH) displayed the simulated environment, controlled the eye-point of the viewer, and animated the DI icons. In addition, STEALTH displayed the dynamic crater and the explosive effects and the hole in the building. ModSAF was used to run the Bradley fighting vehicle and fire the artillery barrage that produced the crater. The ARL DIS manager was used for wide area networking using the DIS protocol.

The demonstration involved controllers at the ARL, Aberdeen Proving Ground, MD site and the show floor at the Sheraton in Washington, DC. The APG site controllers operated a ModSAF and STEALTH. The ModSAF controlled two Bradley fighting vehicles and the enemy artillery barrage. The APG site STEALTH was a mirror of the STEALTH at the Sheraton.

The Washington STEALTH operators controlled the eye-point of the simulation using the mouse and keyboard controls of the STEALTH viewer. In addition. they were responsible for resetting the simulation between scenario runs (Figure 2).

Figure 2 shows the equipment and software used. The equipment is in regular type, and the software is in bold type.

The Sheraton STEALTH controlled the three large screen displays. STEALTH used a single graphics pipeline with three channels. The *ircombine* utility on the SGI Infinite Reality was used to configure the screen placement.

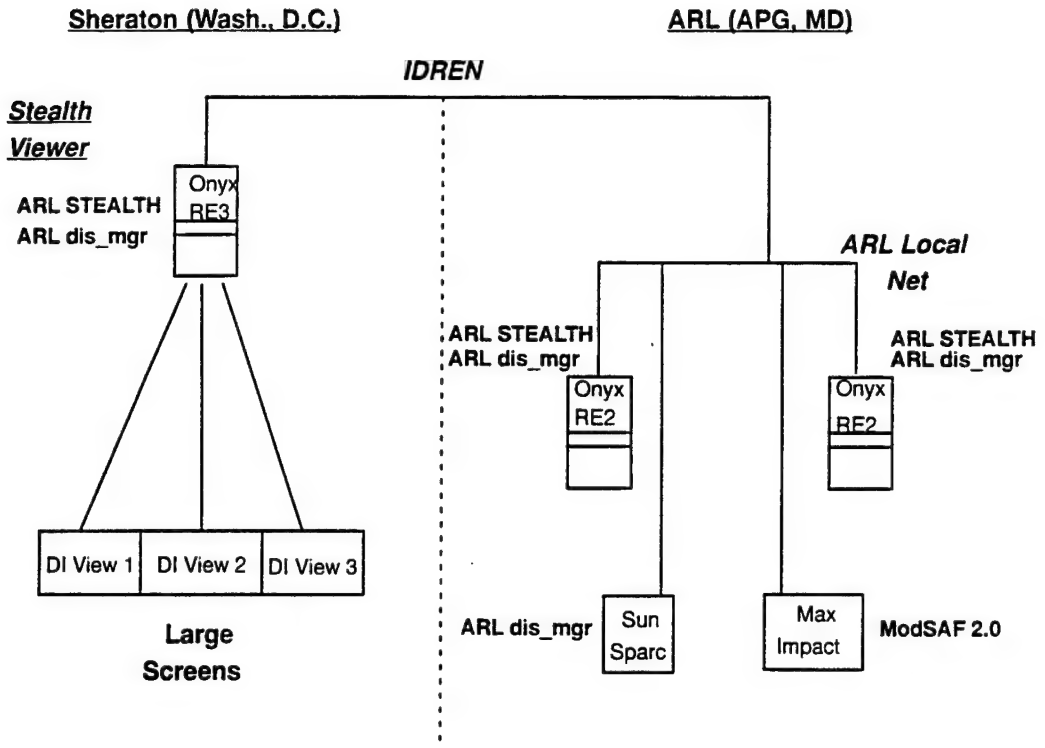

Figure 2. ARL DI Simulation Test Setup.

4. Dismounted Infantry Simulation

To display the dismounted infantry action, the Boston Dynamics DI-Guy icon was used. DI-Guy was selected for its smooth infantry animation and compatibility to existing DIS lifeform enumerations. The DI-Guy DIS interface recognizes DIS enumerations for soldier actions such as walk, run, weapon deployed, stand, kneel, and crawl. DI-Guy provides a programmer interface to control the icon. The programmer may control the head and weapon, and the icon's body will move

appropriately for realistic animation of the desired motion. In addition, the icon's gait can be controlled using speed as a parameter.[1]

Because of the tight sequencing of the scenario, ModSAF was not used for DI simulation, and DIs were controlled using the STEALTH. To animate the icon, the path following utility of the ARL STEALTH was employed. The path following utility of STEALTH uses an ASCII file, which contains directions on how the path should be traversed. The path may include pauses and delays, and azimuth may be given for pauses, allowing the soldier to stop and turn in a direction different from the direction of motion.

The path file also includes a field for icon specific information. The DI-Guy interface uses a discrete identifier for icon actions. This identifier was used in the path files to direct the motion of the icon. The following is the path file for the demolition DI.

```
START 1494.5 1594.5 0.0
PAUSE 0. 1 35.0 0
LEG 1494.5 1594.5 0.0 3.20 11 1492.0 1603.0 0.0
LEG 1492.0 1603.0 0.0 3.20 11 1490.8 1602.5 0.0
PAUSE 1.5 125.0 1
PAUSE -1.0 125.0 0 /* EMPLACE THE BOMB
PAUSE 0.25 125.0 0
PAUSE 0.25 215.0 0
LEG 1490.8 1602.5 0.0 3.2 11 1494.0 1592.0 0.0
PAUSE 2.5 35.0 3
LEG 1494.5 1592.0 0.0 3.2 11 1492.0 1601.7 0.0
PAUSE 15.0 269.0 4
LEG 1492.0 1601.7 0.0 1.2 11 1494.5 1594.5 0.0
PAUSE 15.0 35.0 4
```

Icon speed was computed offline with separate path generation software. This speed was then correlated with the DI-Guy icon to prevent the skating motion that results when speed over ground is faster than the icon's gait. Figures 3–7 show an animation of the DI building clearing attack.

---

[1] Boston Dynamics Inc. "DI-Guy Software for Dismounted Infantry Reference Manual Version 2.01." One Kendall Square, Bldg 100, Cambridge, MA, 20 September 1996.

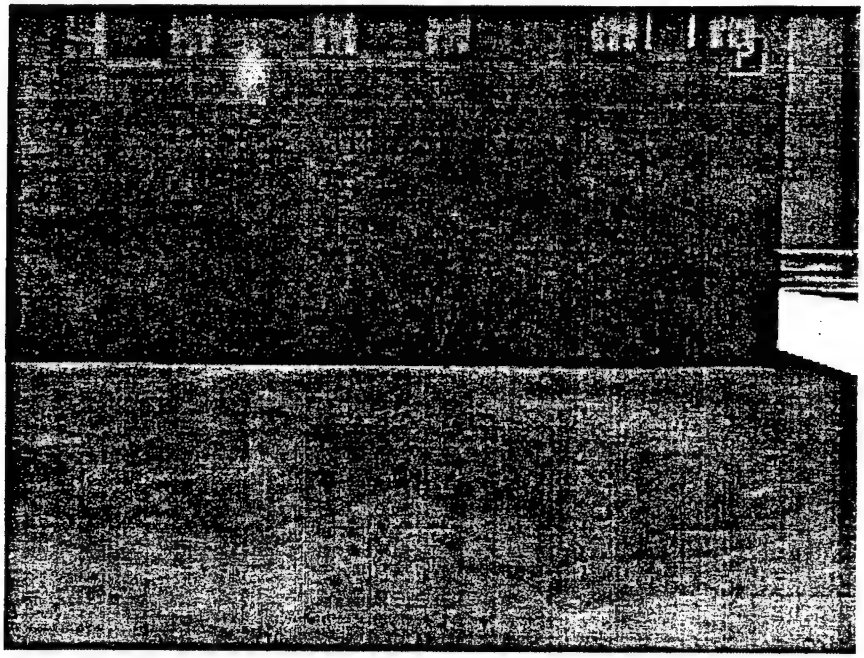

Figure 3. Side of Building.

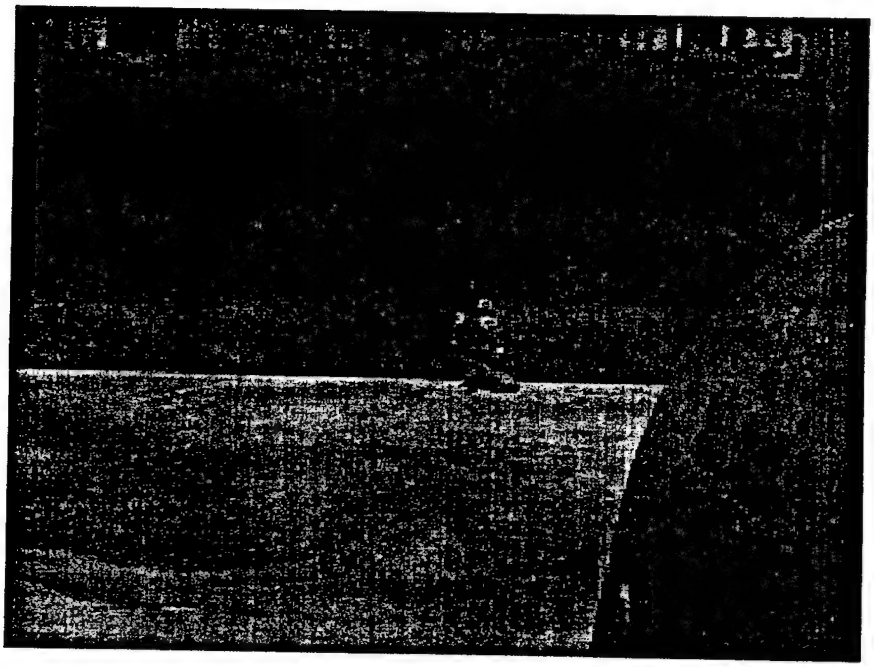

Figure 4. DI Emplacing Charge Demolition Device.

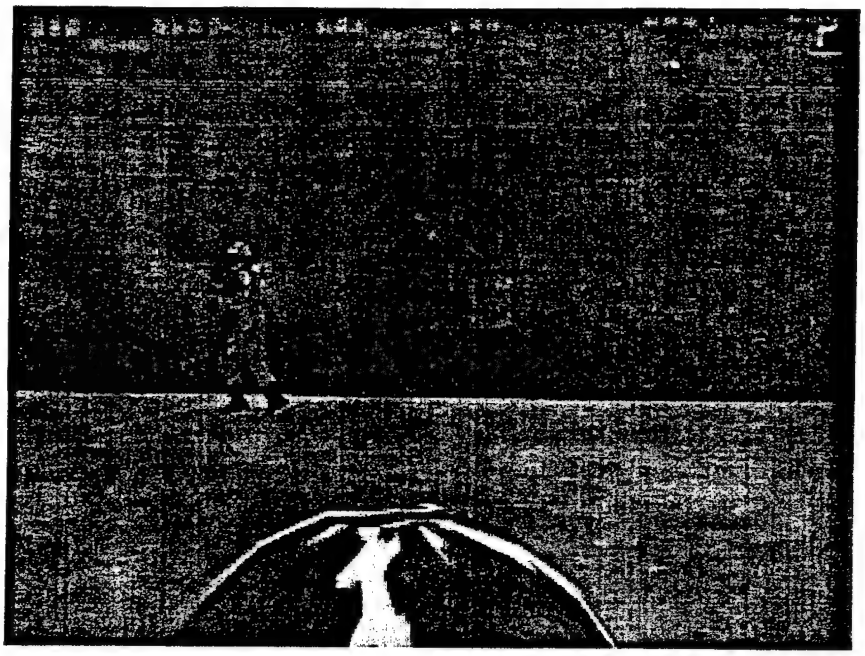

Figure 5. Demolition Device Emplaced on Building.

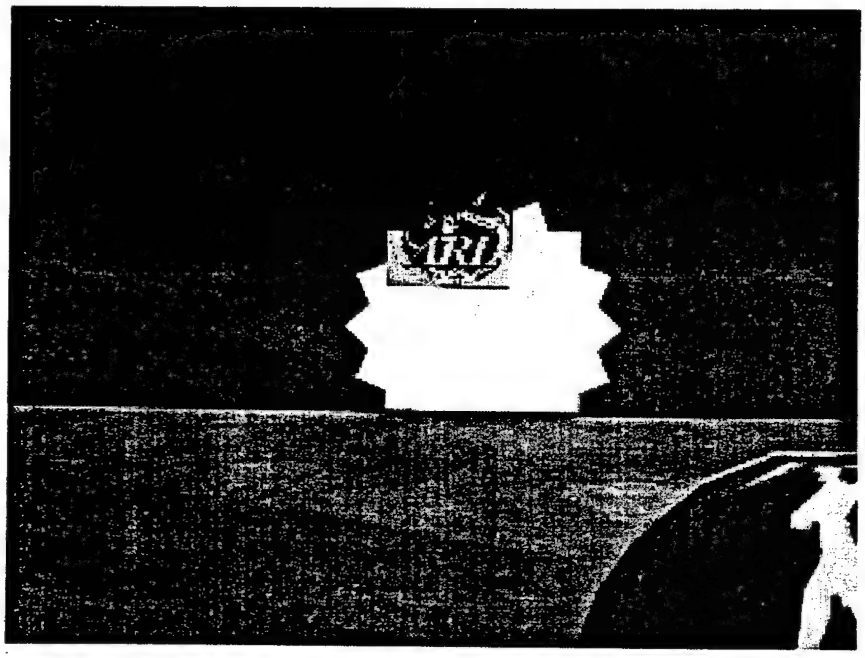

Figure 6. Hole Created From Demolition Device Detonation.

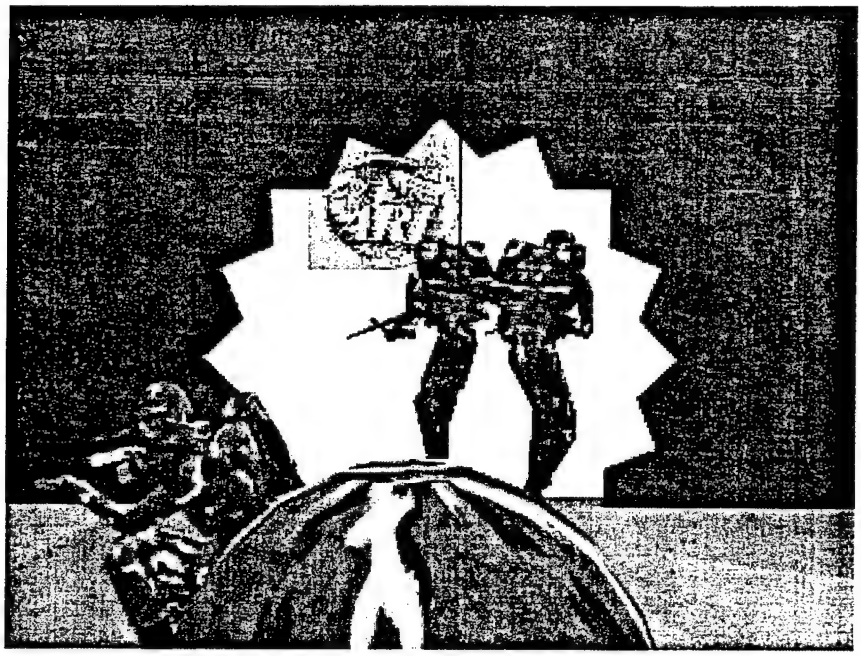

Figure 7. DI Entering and Clearing Building.

5. Dynamic Terrain Simulation

The dynamic terrain (DT) demonstration showed a Bradley infantry fighting vehicle (BIFV) traversing a crater formed by enemy artillery fire. The crater was formed in a segment of a road. The road was extracted from the McKenna MOUT database and gridded at 0.25-m resolution. The road segment was then loaded into STEALTH separately from the rest of the terrain database. At run-time, when a detonation event occurred on the road segment, a crater was computed and the terrain morphed to insert the crater formed (Figures 8 and 9).

The DT simulation was controlled by ModSAF. At the beginning of the scenario, ModSAF executed a Call For Artillery Fire. A Detonation Protocol Data Unit (DPDU) was created and transmitted over the network. When the DPDU was received by the STEALTH viewers, the crater was computed and displayed (Figure 10). At the same time, the Bradley was started on its way to pick up the DIs in the village and traversed the crater en route.

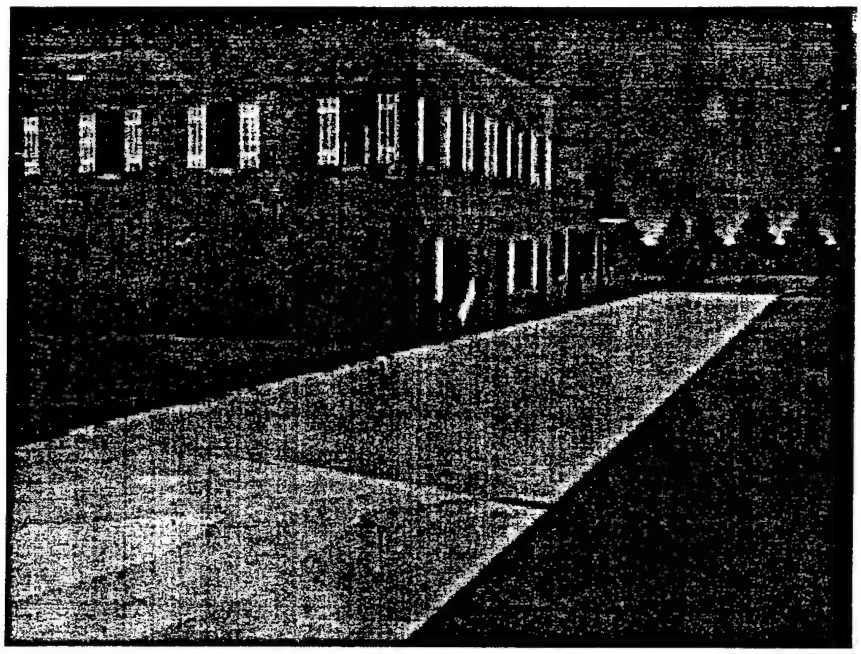

Figure 8. McKenna Mout Site Road.

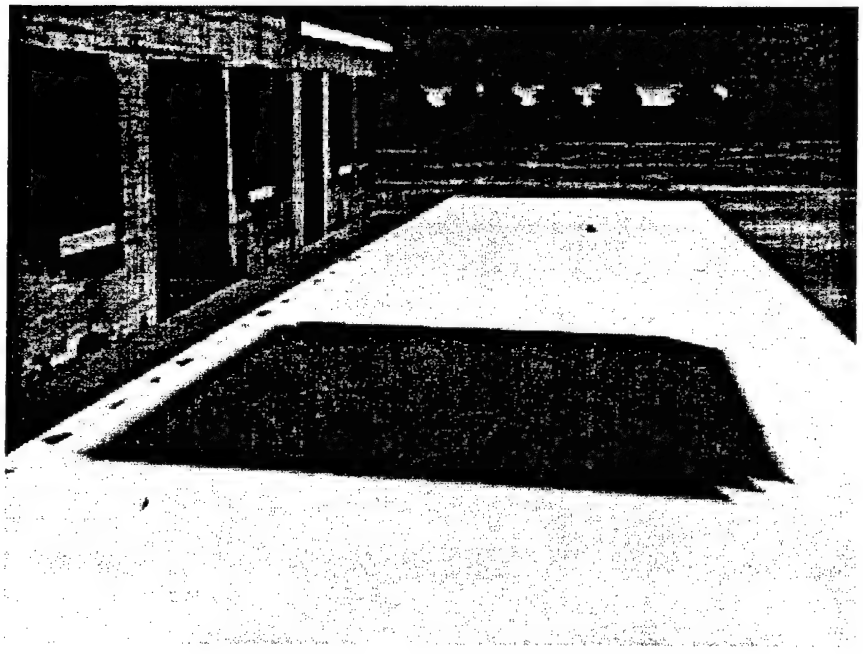

Figure 9. Road With Dynamically Created Crater.

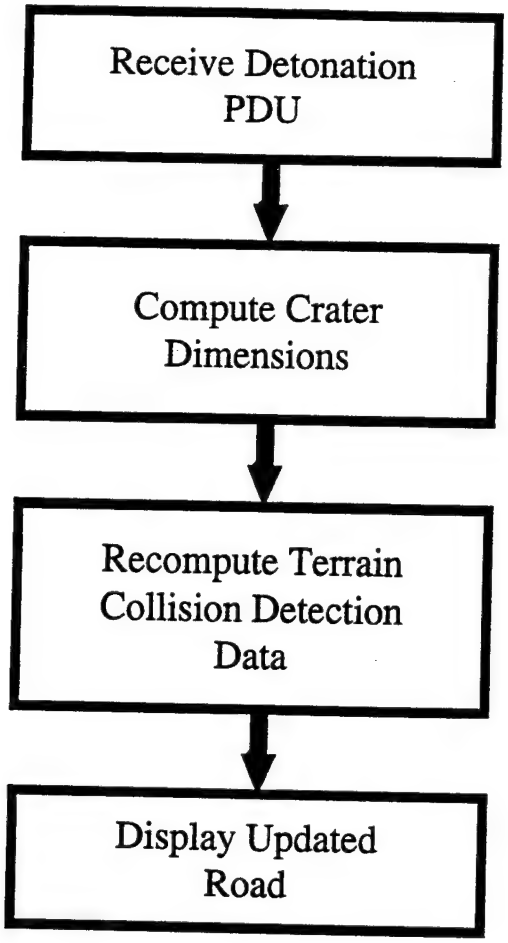

Figure 10. Process Flow for Dynamic Terrain.

6. Conclusion

This report describes the ARL DIS for the AE3 at the AUSA show in Washington, DC, during October 1996. The demonstration showed how simulation could be used to show a realistic urban environment in which to train infantry urban warfare tactics. The ability to blow a hole into a wall, providing ingress to a building, and dynamic cratering are important considerations for infantry tactics and were demonstrated successfully during the AUSA show.

Bibliography

Pearson, R., R. Kvavilashvili, A. Neiderer, and M. Thomas. "Penetration Effects on Urban Structures." *Proceedings of the 8th International Symposium on the Interaction of Munitions With Structures*, Alexandria, VA, 22–25 April 1997.

Smith, K. "Distributed Interactive Simulation (DIS) Network Manager." ARL-TR-780, U.S. Army Research Laboratory, Aberdeen Proving Ground, MD, June 1995.

INTENTIONALLY LEFT BLANK.

NO. OF
COPIES ORGANIZATION

2 DEFENSE TECHNICAL
INFORMATION CENTER
DTIC DDA
8725 JOHN J KINGMAN RD
STE 0944
FT BELVOIR VA 22060-6218

1 HQDA
DAMO FDQ
DENNIS SCHMIDT
400 ARMY PENTAGON
WASHINGTON DC 20310-0460

1 CECOM
SP & TRRSTRL COMMCTN DIV
AMSEL RD ST MC M
H SOICHER
FT MONMOUTH NJ 07703-5203

1 PRIN DPTY FOR TCHNLGY HQ
US ARMY MATCOM
AMCDCG T
M FISETTE
5001 EISENHOWER AVE
ALEXANDRIA VA 22333-0001

1 PRIN DPTY FOR ACQUSTN HQS
US ARMY MATCOM
AMCDCG A
D ADAMS
5001 EISENHOWER AVE
ALEXANDRIA VA 22333-0001

1 DPTY CG FOR RDE HQS
US ARMY MATCOM
AMCRD
BG BEAUCHAMP
5001 EISENHOWER AVE
ALEXANDRIA VA 22333-0001

1 DPTY ASSIST SCY FOR R&T
SARD TT T KILLION
THE PENTAGON
WASHINGTON DC 20310-0103

1 OSD
OUSD(A&T)/ODDDR&E(R)
J LUPO
THE PENTAGON
WASHINGTON DC 20301-7100

NO. OF
COPIES ORGANIZATION

1 INST FOR ADVNCD TCHNLGY
THE UNIV OF TEXAS AT AUSTIN
PO BOX 202797
AUSTIN TX 78720-2797

1 USAASA
MOAS AI W PARRON
9325 GUNSTON RD STE N319
FT BELVOIR VA 22060-5582

1 CECOM
PM GPS COL S YOUNG
FT MONMOUTH NJ 07703

1 GPS JOINT PROG OFC DIR
COL J CLAY
2435 VELA WAY STE 1613
LOS ANGELES AFB CA 90245-5500

1 ELECTRONIC SYS DIV DIR
CECOM RDEC
J NIEMELA
FT MONMOUTH NJ 07703

3 DARPA
L STOTTS
J PENNELLA
B KASPAR
3701 N FAIRFAX DR
ARLINGTON VA 22203-1714

1 USAF SMC/CED
DMA/JPO
M ISON
2435 VELA WAY STE 1613
LOS ANGELES AFB CA
90245-5500

1 US MILITARY ACADEMY
MATH SCI CTR OF EXCELLENCE
DEPT OF MATHEMATICAL SCI
MDN A MAJ DON ENGEN
THAYER HALL
WEST POINT NY 10996-1786

1 DIRECTOR
US ARMY RESEARCH LAB
AMSRL CS AL TP
2800 POWDER MILL RD
ADELPHI MD 20783-1145

NO. OF
COPIES ORGANIZATION

1 DIRECTOR
US ARMY RESEARCH LAB
AMSRL CS AL TA
2800 POWDER MILL RD
ADELPHI MD 20783-1145

3 DIRECTOR
US ARMY RESEARCH LAB
AMSRL CI LL
2800 POWDER MILL RD
ADELPHI MD 20783-1145

ABERDEEN PROVING GROUND

4 DIR USARL
AMSRL CI LP (305)

NO. OF COPIES	ORGANIZATION
1	USA STRICOM PM DIS AMCPM DIS CENTRAL FLORIDA RSRCH PK 12350 RSRCH PKY ORLANDO FL 32826-3276
1	USA STRICOM AMSTI ET TRACI JONES CENTRAL FLORIDA RSRCH PK 12350 RSRCH PKY ORLANDO FL 32826-3276
1	COMMANDANT ATSH CDA JAN CHERVENAK DISMOUNTED BATTLESPACE BATTLE LAB USIS FT BENNING GA 31905-5400
1	HIGH PERFORMANCE TECHLGIES VIRGINIA TO 9391 BEARDS HILL RD STE 101 ABERDEEN MD 21001
1	REALITY BY DESIGN PAUL BARHAM 867 WAVE ST STE 200 MONTEREY CA 93940-1054
1	USA NATICK RDE CENTER SSCNC AAM JOHN OKEEFE KANSAS ST NATICK MA 01760-5015

NO. OF COPIES	ORGANIZATION
	ABERDEEN PROVING GROUND
19	DIR USARL AMSRL IS DR J GANTT R SLIFE P EMMERMAN AMSRL IS E COL R PRICE AMSRL IS ES MAJ VAGLIA M A THOMAS J FORESTER E HEILMAN A NEIDERER J OMAY AMSRL HR DR R KEESEE B CORONA AMSRL HR MB R SPENCER J FAUGHN AMSRL WM AMSRL WM WE J LACETERA P FAZIO AMSRL CI W MERMAGEN A MARK

INTENTIONALLY LEFT BLANK.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	January 1998	Final, Dec 95 - Oct 96

4. TITLE AND SUBTITLE
The ARL Army Experiment 3 Individual Combatant/Military Operations on Urbanized Terrain (MOUT) Demonstration

5. FUNDING NUMBERS
P622618.H80

6. AUTHOR(S)
Mark A. Thomas

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Army Research Laboratory
ATTN: AMSRL-IS-ES
Aberdeen Proving Ground, MD 21005-5066

8. PERFORMING ORGANIZATION REPORT NUMBER
ARL-TN-102

9. SPONSORING/MONITORING AGENCY NAMES(S) AND ADDRESS(ES)

10.SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT ***(Maximum 200 words)***

In October 1996, the U.S. Army presented a demonstration of wargaming and virtual prototyping at the Annual Association of the U.S. Army (AUSA) Convention in Washington DC. The demonstration showcased interactive simulation and its use in military operation planning, situational awareness, battlefield coordination, and infantry tactics. The U.S. Army Research Laboratory (ARL) participated by demonstrating infantry tactics in an urban area. The ARL demonstration included dismounted infantry (DI) maneuvering in a built-up area to clear a building, and dynamic effects on terrain and manmade structures. This report describes the ARL military operations on urbanized terrain (MOUT) demonstration.

14. SUBJECT TERMS
individual combatant, MOUT, MOBA, real-time simulation, interactive simulation

15. NUMBER OF PAGES
20

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UL

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18 298-102

INTENTIONALLY LEFT BLANK.

USER EVALUATION SHEET/CHANGE OF ADDRESS

This Laboratory undertakes a continuing effort to improve the quality of the reports it publishes. Your comments/answers to the items/questions below will aid us in our efforts.

1. ARL Report Number/Author ARL-TN-102 (Thomas) Date of Report January 1998

2. Date Report Received _____

3. Does this report satisfy a need? (Comment on purpose, related project, or other area of interest for which the report will be used.) _____

4. Specifically, how is the report being used? (Information source, design data, procedure, source of ideas, etc.) _____

5. Has the information in this report led to any quantitative savings as far as man-hours or dollars saved, operating costs avoided, or efficiencies achieved, etc? If so, please elaborate. _____

6. General Comments. What do you think should be changed to improve future reports? (Indicate changes to organization, technical content, format, etc.) _____

CURRENT ADDRESS

Organization

Name E-mail Name

Street or P.O. Box No.

City, State, Zip Code

7. If indicating a Change of Address or Address Correction, please provide the Current or Correct address above and the Old or Incorrect address below.

OLD ADDRESS

Organization

Name

Street or P.O. Box No.

City, State, Zip Code

(Remove this sheet, fold as indicated, tape closed, and mail.)

(DO NOT STAPLE)